Modelling interest rates pass-through in Nigeria: An error correction approach with asymmetric adjustments and structural breaks

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Modeling Interest Rates Pass-through in Nigeria: An Error Correction Approach with Asymmetric Adjustments and Structural Breaks[1]

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ABSTRACT

This paper investigates the size and adjustment pattern of the interest rate pass-through (IRPT) between the policy-controlled interest rate (MPR) and seven (7) retail interest rates (lending and deposit rates) in Nigeria. This study departs from previous studies on Nigeria in the sense that it takes account of the effects of structural breaks in our modelling approach. First, we confirm the existence of long-run relationships between MPR and two retail rates (prime lending rate and savings deposit rate), albeit with significant structural breaks occurring in their cointegrating vectors at different periods. Second, we find evidence of incomplete pass-through in the response of the retail rates to MPR shocks. Third, most of the retail interest rates adjust symmetrically to changes in the policy rate, with the exception of the savings rate. This implies that the response of savings rate varies depending on whether the innovation in the MPR is positive or negative. Fourth, positive innovations in the MPR are fully reflected in the savings rate within 2 months as against 8 months for negative MPR shocks. Fifth, innovations in the MPR are fully transmitted to the prime lending rate in about 14 months while the complete pass-through to the 6-month time deposit rate occurs in about 11 months. In view of these findings, we recommend that the monetary authority should always have an eye on the size of the pass-through as well as the heterogeneities found in the adjustment process of the retail rates while taking decisions on its policy rate. Also, the low IRPT obtained suggests a stronger monetary policy stance or other supplementary measures if the objectives of MPR changes are to be fully realized.

JEL Classifications: *E43, E52, E58,*

Keywords: Interest rate pass-through, Cointegration, Asymmetric adjustments, Structural Break

[1] *The views expressed in the paper are those of the authors and do not reflect those of the Bank or its policy*

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1.0 Introduction

The interest rate channel of monetary policy describes the process by which changes in short-term policy interest rate of the central bank affect the overall economy via changes in the commercial banks' retail interest rates. Thus, short-term policy interest rate has been recognized as a useful operating instrument of monetary policy, especially amongst inflation targeting countries. This is premised on the tenets of the new consensus macroeconomics, which believes in the potency of short-term interest rate in achieving price stability (Arestis, 2007). However, the continued use of short-term interest rates as a monetary policy tool by central banks rests strongly on the belief that there exists a significant and swift interest rate pass-through in the economy. Interest rate pass-through (IRPT) refers to the degree and speed of adjustment of retail interest rates to changes in the monetary authority's policy rate (Aydin, 2007). The consensus amongst policy makers is that effective monetary policies are associated with changes in the policy rates that are fully transmitted to the retail interest rates (that is, complete pass-through) within a reasonably short period of time (Bernanke and Gertler, 1995; Ahmad *et al.* 2013).

In the literature, the results have been mixed with regard to the extent and speed of IRPT. Most studies (especially in developed countries) suggest that interest rate pass-through has been both small in degree and slow in adjustment in response to changes in the official rate (Heffernan, 1993; Sanusi, 2010; Yildirim, 2012, Petrevski and Bogoev, 2012; Ahmad *et al*, 2013; Ogundipe and Alege, 2013) while others have documented a high and quick IRPT (e.g. Karahan, 2014; Yuksel and Ozcan, 2013). Significant heterogeneities have also been found in the degree and speed of IRPT in lending rates across different sectors and deposit rate across different maturities (Aydin, 2007). Another strand of literature investigates the issue of asymmetry in the IRPT (Yuksel and Ozcan, 2012).

In Nigeria, the monetary policy rate (MPR) has emerged as a key monetary policy tool for the Central Bank of Nigeria (CBN). At its bi-monthly meetings, the Monetary Policy Committee (MPC) of the CBN sits to set the MPR based on its judgment regarding the current state of the economy as well as its expected future path. The ultimate goal in this regard is to be able to influence prices and aggregate demand in the economy

using the policy rate. It therefore becomes increasingly important for policy makers to correctly understand the dynamics of IRPT for better monetary policy decisions or outcomes.

For ease of exposition, the remainder of the paper is structured as follows; section 2 discusses some stylized facts on interest rates movements in Nigeria and highlights the findings of previous studies on IRPT in Nigeria, section 3 outlines the data and econometric framework for the empirical analysis , section 4 presents and discusses the empirical results and section 5 concludes.

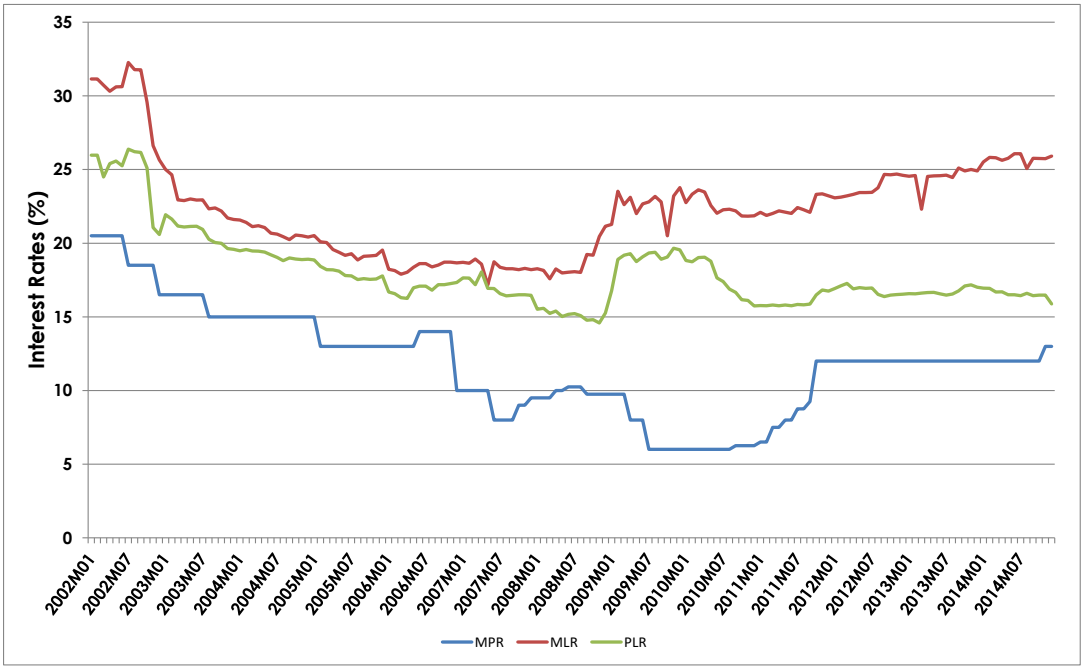
2.0 Stylized Facts—Trends in Interest Rates and Findings on IRPT in Nigeria

Chart 1 presents a time series plot of the monetary policy rate (mpr) and the maximum (mlr) and prime (plr) lending rates. The chart seems to suggest that movements in the mpr lead that of mlr and plr, as to be expected given that market operators do react to actions taken by policy makers[3]. Indeed, the general belief in the literature is that operators (or commercial banks) would ordinarily adjust one-for-one their retail interest rates in response to changes in policy rate. In practice, however, such expectation is not often observed, as commercial banks tend to adjust their retail rates in response to changes in policy rates with some lags (or delays) thereby constituting an impediment to the ability of the central bank to guide the economy to the desired direction. A number of reasons have been advanced to explain why commercial banks retail rates tend to be somewhat sticky, namely credit rationing and adverse selction, switching costs, risk sharing, consumer irrationality, structure of the financial system, state of financial sector development, menu costs and information asymmetry.

From Chart 1, while the rates experienced a gradual and steady downward trend between 2002 and 2008, the trend reversed towards the end of 2009 as there were increases in the retail rates during the global financial crisis, even though the mpr was lowered. The sharp movements in the rates between 2009 and early 2011 suggest the possibility of structural breaks in the relationships between the mpr and each of the lending rates.

[3] The monetary policy rate (MPR) was introduced in December 2006 to replace the erstwhile minimum rediscount rate (MRR), which had used as a key short-term interest rate of the Central Bank of Nigeria, to signal the stance of monetary policy and provide general direction on interest rate movements. The MPR is set as the mid-point of the standing lending facility (SLF) and the standing deposit facility (SDF) window rates.

Chart 1: Time Series Plot of Monetary Policy, Maximum Lending, and Prime Lending Rates, 2002 - 2014



Source: *CBN Statistics Database*

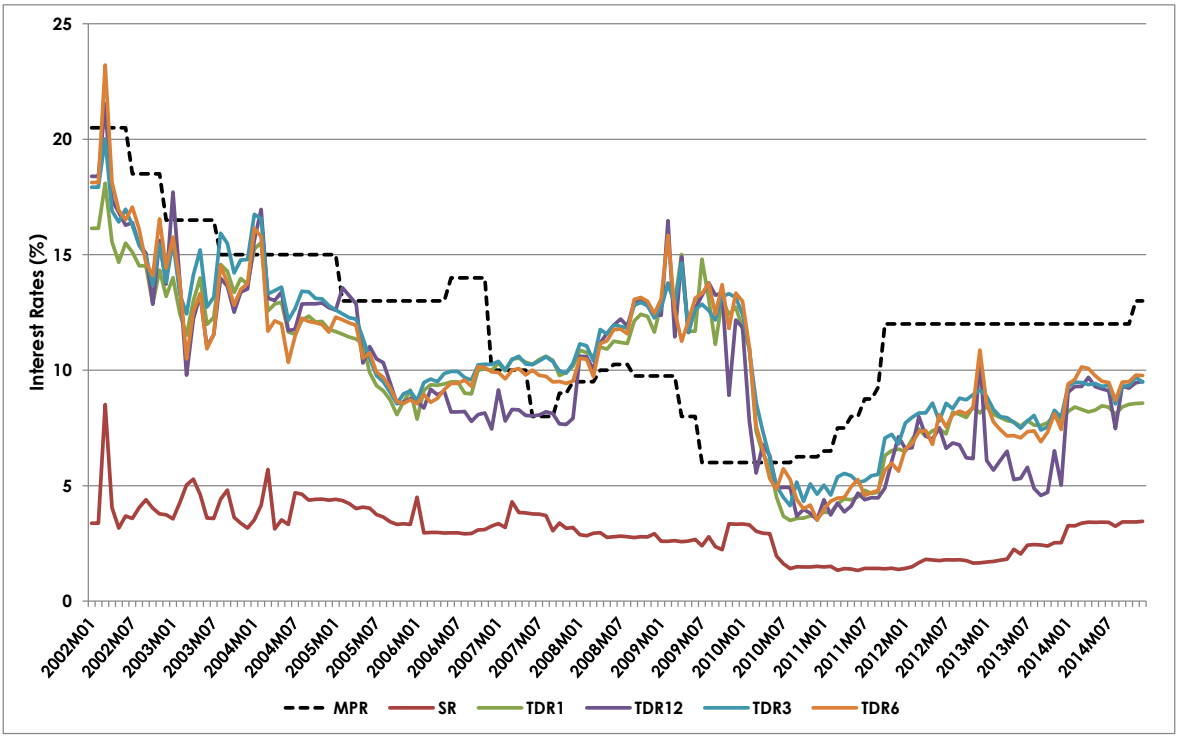
In chart 2, where we have plotted the mpr along with five categories of deposit rates, such sharp and large movements were also witnessed during the period of the global financial crisis. While the movements in the retail rates seem to reflect developments in the policy rate, the exact relationship as well as the degree of pass-through cannot be determined by examining Charts 1 and 2.

The correlation matrix between the mpr (contemporaneous and lagged up to 12 lags) and the contemporaneous lending and deposit rates in Table 1, shows that there is a positive correlation between mpr and the two lending rates—mlr and plr, and between the mpr and the five deposit rates used in the study. It is evident from the table that the correlation is not perfect, as the correlation coefficients were generally less than one. The correlation coefficients for all the retail interest rates (except the mlr) tended to increase with increasing lags of mpr peaking at some lags along the lag chain. This may suggest a possible lag response of commercial banks to monetary policy shocks.

The correlation coefficient peaked at 0.43 (contemporaneously) for the maximum lending rate (mlr) and declined steadily thereafter for lagged mpr until lags 10-12 when

it actually turned negative. For the prime lending rate the contemporaneous correlation coefficient is 0.66, which rose steadily to peak at approximately 0.67 from lag 3 to lag 8 before declining marginally to 0.66 from lag 9 to lag 12 but remained in the positive zone all through. The correlation analysis between the mpr and the lending rates casts some doubts as to whether commercial banks' actually pay attention to the mpr in fixing their maximum lending rates with the recorded low and declining correlation coefficient.

Chart 2: Time Series Plot of Monetary Policy and selected Deposit Rates in Nigeria, 2002 - 2014



Source: *CBN Statistics Database*

In the case of deposit rates the correlation coefficients are positive contemporaneously and at all lagged mpr considered in the analysis; they are generally 0.55 or higher. The correlation coefficient for the savings deposit rate (sr) peaked at 0.81 at mpr(-12), 0.67 for the 1-month time deposit rate (tdr1) at mpr(-10), 0.69 for the 3-month time deposit rate (tdr3) at mpr(-10), 0.65 for the 6-month time deposit rate (tdr6) at mpr(-7) and approximately 0.61 for 12-month time deposit rate (tdr12) at mpr(-2 to -8). While it is not advisable to read much meaning into these numbers, the moderate correlation

coefficients could be an indication that the pass-through from policy rate to retail rates might be low/non-existent and incomplete in Nigeria while the pattern of lagged correlation may point to a very slow speed of adjustment on the part of commercial banks. Be that as it may, there is, however, need for a more rigorous empirical analysis to facilitate meaningful conclusions on the nature of IRPT in Nigeria.

Table 1: Correlation Matrix-Monetary Policy Rate vis-à-vis Lending and Deposit Rates

	mpr	mpr(-1)	mpr(-2)	mpr(-3)	mpr(-4)	mpr(-5)	mpr(-6)	mpr(-7)	mpr(-8)	mpr(-9)	mpr(-10)	mpr(-11)	mpr(-12)
mlr	*0.4274*	0.4005	0.3699	0.3409	0.3048	0.2645	0.2185	0.1604	0.1011	0.0330	-0.0304	-0.0784	-0.1258
plr	0.6554	0.6583	0.6635	0.6684	*0.6702*	0.6697	0.6660	0.6661	0.6651	0.6638	0.6607	0.6590	0.6554
sr	0.5509	0.5737	0.6007	0.6058	0.6308	0.6691	0.6941	0.7157	0.7405	0.7589	0.7778	0.7950	*0.8093*
tdr1	0.5651	0.5856	0.6012	0.6067	0.6205	0.6344	0.6437	0.6537	0.6592	0.6608	*0.6664*	0.6624	0.6525
tdr3	0.6201	0.6337	0.6451	0.6496	0.6563	0.6658	0.6732	0.6798	0.6815	0.6837	*0.6871*	0.6801	0.6706
tdr6	0.5913	0.6042	0.6175	0.6223	0.6260	0.6355	0.6453	*0.6518*	0.6509	0.6473	0.6440	0.6292	0.6128
tdr12	0.5862	0.5968	0.6092	0.6090	0.6065	0.6062	0.6084	0.6125	0.6054	0.5948	0.5950	0.5799	0.5665

Source: Authors' Computation.

mpr = Monetary Policy Rate (or Minimum Rediscount Rate (MMR))
mlr = Maximum Lending Rate
plr = Prime Lending Rate
sr = Savings Deposit Rate
tdr1 = One-Month Time Deposit Rate
tdr3 = Three-Month Time Deposit Rate
tdr6 = Six-Month Time Deposit Rate
tdr12 = Twelve-Month Time Deposit Rate

The literature on IRPT is vast, particularly for developed countries while for emerging and developing countries, the literature is growing. In sub-Saharan African countries, including Nigeria, where most of the countries have implemented series of reforms, limited attention has been paid to analyzing interest rate pass-through notwithstanding its prominent role in the monetary policy transmission process. To the best of our knowledge, studies of IRPT in Nigeria are fairly recent and limited (Haruna (2010); Sanusi, 2010; Bangura (2011); Fomum (2011); Mangwengwende (2011); Mangwengwende et al. (2011); Ogundipe and Alege, 2013); Mustapha et al. (2013); and Kelilume (2014)).[4] All the authors found an incomplete and slow IRPT.

Sanusi (2010) estimated the magnitude and speed of the interest rate pass-through for Nigeria using monthly data for the period 2002-2010 and a structural vector auto-regression (SVAR) model to derive the dynamic elasticities of the pass-through of monetary policy rate and interbank interest rates to the retail lending and deposit

[4] Haruna (2010) did not carry out any empirical analysis and as at the time of writing an update has not been seen anywhere. The paper merely indicated that a VAR technique along with a symmetric and an asymmetric error correction modelling technique would be used for the analyses.

interest rates. He found that interest rate pass-through in Nigeria is incomplete and quite slow. His results also show that the pass-through of monetary policy rate to interbank money market rates is substantially larger and faster than they are for the retail lending and deposit rates. He argued that the banking and financial sector reforms implemented over the years have failed to remove the distortions in the retail loans and deposit markets and added that such distortions in the retail loans and deposit market would continue to render monetary policy ineffective and inefficient in the country.

Bangura (2011) use monthly data spanning the period 1989:01-2009:12 to analyze the similarities or otherwise between interest rate pass-through in four Anglophone West African countries within the West African Monetary Zone (WAMZ) including Nigeria. The study explored the interest rate adjustment dynamics using the discount rate, treasury bill rate, commercial banks' deposit and lending rates in all the countries studied. It set out to specifically examine how lending and deposit rates respond to changes in the official rates and to establish whether there is a convergence among the rates over time and the relative adjustment of lending rates to changes in the official rate when there is a disequilibrium. Full sample period and a rolling window analysis were conducted while the cointegration technique and an asymmetric error model to derive the short-run and long-run parameters from which the error correction coefficients, mean adjustment lags and asymmetric mean adjustment lags were estimated. For Nigeria, the main findings are: the long-run pass-through is 0.81 for the lending rate and 0.67 for the deposit rate while the short-run pass-through is 0.66 and 0.47, respectively, using the full sample; the pass-through estimates in the case of rolling windows analysis were mixed both in the short-run and long-run—ranging from 0.13 to 1.10 for the long-run and -0.04 to 1.08 for the short-run lending rate and -0.03 to 1.18 and -0.08 to 0.78, respectively, for the long-run and short-run deposit rates; the mean adjustment lags suggest speed of adjustment of the lending rate for the full sample is two for deposit rates it is seven; the average speeds of adjustment for the rolling windows are four and five months, respectively, for lending and deposit rates; there are asymmetries in deposit rates and downward rigidity in both lending and deposit rates in Nigeria based on the full sample; and in the case of rolling windows, mixed results were obtained.

Fomum (2011) performed a comparative analysis of interest rate pass-through in Cameroon and Nigeria using retail rates (lending and deposit) and a discount rate (policy rate) for the spanning January 1990 through December 2010. Specifically, the study analyzed the magnitude and speed of retail rate adjustments to changes in the central bank policy rate and examined whether there is symmetric or asymmetric pass-through in addition to investigating if there is pass-through transmission from one country to the other. According to the author, four varieties of cointegrating techniques (system-based Johansen-Juselius (JJ), and single equation-based Engle-Granger (EG), cointegration regression Durbin-Watson (CRDW) and ECM-based) were used to test for the presence of a cointegrating long-run relationship between the policy rate and the retail rates to guarantee the robustness of the relationship identified. In addition, following the work of Cottarelli and Kourelis (1994), three sets of analyses were undertaken: first, to analyze pass-through for the entire sample, second, to analyze symmetric and asymmetric pass-through using a ten year rolling window analysis in an error correction framework, and third, the policy rates were swapped to investigate any transmission of impulses from one country to another. For Nigeria, some of the key findings include: cointegrating relationship was confirmed for the lending rate by the EG, CRDW and ECM tests and by EG and ECM for the deposit rate; short-run pass-through coefficients are 0.71 for lending rate and 0.50 for deposit rate, but overall sluggish; long-run pass-through are almost similar at 0.72 and 0.70, respectively for the lending and deposit rates suggesting a sluggish and incomplete pass-through; pass-through mechanism is symmetric for both the lending and deposit rates; the mean adjustment lag is 4.9 months for lending rates and 7 months for deposit rate; asymmetric adjustment was confirmed in six rolling windows for lending rate in Nigeria of which three indicated that the direction of rigidity is downward supporting the *collusive pricing arrangement* between banks (Scholnick, 1996) and the other three suggested rigidity in the upward direction confirming the *customer reaction hypothesis* (Scholnick, 1996); monetary policy are highly effective in Nigeria compared to Cameroon; and policy rate in Nigeria exerts some influence on the deposit rate in Cameroon.

Mangwengwende (2011) and Mangwengwende et al. (2011) investigated the relationship between bank concentration and interest rate pass-through in four Sub-

Saharan African countries namely Botswana, Nigeria, South Africa and Zambia.[5] Similar to the study by Fomum (2011), both studies employed both the JJ and the EG (encompassing the residual-based, CRDW and ECM) techniques to test for cointegration among the policy rate and lending and deposit rates in these countries. Rolling windows analyses were also carried out in addition to tests for symmetric and asymmetric adjustments in the pass-through. The major findings with respect to Nigeria are: cointegration is confirmed for the deposit and lending rates by only two of the testing techniques employed; the rolling window analysis confirmed cointegration with the policy rate for all deposit rates but in the case of lending rates the results are mixed; symmetric error correction for both lending and deposit rates is significant and lending rates adjust faster than deposit rates; asymmetric results were also significant for deposit rates, and adjustments downward were slower than deposit rate adjustment upward, providing support for *adverse consumer reaction hypothesis*; and overall, pass-through is largely low and sluggish (incomplete).

Ogundipe and Alege (2013) investigated interest rate pass-through in Nigeria using both the system-based Johansen-Juselius (JJ) and the single equation Engle-Granger (EG) two-step cointegration procedures with annual data for the period 1970-2011. Using the VAR-based error correction model (ECM) and the mean adjustment lag (MAL), the authors determined the short run estimates and the asymmetric behaviour, respectively. They found evidence of downward stickiness both in the short-run and long run policy rate pass-through to the retail bank rates. For robustness, the authors conducted impulse response and variance decomposition analyses and obtained similar slow and sluggish (incomplete) pass-through.[6]

Mustapha et al. (2013) focused only on the lending rate pass-through from policy to retail interest rates in their study within the framework of the Taylor principle and came to a similar conclusion that the pass-through is incomplete in Nigeria during the period covered by the study. This, according to them, contradicts the Taylor principle and has

[5] Mangwengwende et al. (2011) is actually based on the work of Mangwengwende (2011).

[6] Although, Ogundipe and Alege (2013) made an effort to examine the issue of asymmetry in interest rate pass-through in Nigeria, as per Table 3, p. 28 of their paper, they failed to analyse or interpret their results.

implications for the stabilizing role of monetary policy and the oscillations arising from price and liquidity shocks.

Kililume (2014) examined the effects of monetary policy rate on interest rates in Nigeria using monthly data from January 2007 to September 2012 and a multivariate vector autoregressive model. The interest rate variables employed for the empirical analysis include the monetary policy rate (mpr) and five retail interest rates variables–savings deposit rate (sdr), interbank rates (ibr), prime lending rate (plr), maximum lending rate (mlr) and long term interest rates in the 91-day treasury bill rate (tbr). The key findings from the study are: the pass-through of mpr to short-term and long term retail rates in Nigeria is sticky; the only indication of the effectiveness of monetary policy is seen only in the relationship between the mpr and interbank rates; there is a weak relationship between mpr and retail rates in Nigeria; and overall, there is weak interest rate pass-through in Nigeria.

Even though these studies covered the period of the global financial crisis and spanned a fairly long period of time, they failed to account for structural breaks in their modeling approach[7]. This study attempts to fill this gap. Thus, the main objective of this study is to investigate interest rate pass-through from the policy rate to selected retail interest rates in Nigeria while accommodating asymmetric adjustments and structural breaks in our modeling approach. Specifically, we estimate the degree of IRPT to different retail rates in Nigeria and their speeds of adjustment to innovations in the policy rate. Also, we investigate whether there is evidence of asymmetry and heterogeneities in the adjustment process of the rates. The achievement of these objectives has significant policy relevance as it would help to improve the design and execution of effective monetary policy in Nigeria.

3.0 Data and Methodology

Unlike previous Nigerian studies, we estimated an asymmetric error correction model that accounts for endogenously determined structural breaks in the cointegrating equation for the IRPT. The first step in the estimation approach involved testing for stationarity in our variables, after which bivariate cointegration tests were conducted

[7] This could lead to parameter bias and wrong estimates for the degree of interest rate pass-through.

between the policy rate and the different retail rates being considered. The single equation approach to cointegration and error correction of Engle and Granger (1987) and Gregory and Hansen (1996) are employed. The Neumark and Sharpe (1992) approach to understanding asymmetric adjustment processes is employed and the adjustment mean lag is computed as proposed by Doornik and Hendry (1994) and adopted by Scholnick (1996).

3.1 Data

The study utilizes monthly data on the monetary policy rate (mpr) and seven retail rates, which are: maximum lending rate (mlr), prime lending Rate (plr), savings rate (sr), 1-month time deposit rate (tdr1), 3-month time deposit rate (tdr3), 6-month time deposit rate (tdr6) and 12-month time deposit rate (tdr12). All the data were sourced from the Statistics Database of the Central Bank of Nigeria. The sample period spans 2002:01 to 2014:12.

3.2 Model

The basic equation for analyzing IRPT is the marginal cost pricing model of the form:

$$y_{it} = \alpha_i + \beta_i x_t + \varepsilon_{it} \qquad (1)$$

where y_{it} is the different retail interest rates set by commercial banks at time t (which includes mlr, plr, sr, tdr1, tdr3, tdr6, tdr12), x_t represents the policy rate (mpr), α_i is a mark up for the different retail interest rates, β_i captures the extent of long-run IRPT for each of the retail rates, and ε_{it} is the residuals from the different retail interest rate equations. $\beta_i<1$ indicates incomplete pass-through, $\beta_i=1$ implies complete pass-through and $\beta_i>1$ denotes an over pass-through.

3.3 Estimation Procedure

The econometric procedure adopted follows the work of Scholnick (1996). However, the only area of departure is in the procedure for the cointegration test. While Scholnick adopted the Johansen technique, we chose the Gregory and Hansen (1996) residual-based approach in order to account for structural breaks in the cointegrating relationship. Engle and Granger (1987) approach to testing for cointegration tends to under-reject the null of no cointegration if there is a cointegration relationship that has

changed at some (unknown) time during the sample period, implying low power (Harris and Sollis, 2003). Gregory and Hansen (1996) developed four different models to test for cointegration with structural beaks. These are models with: (i) level shift, C (GH-1); (ii) level shift with trend, C/T (GH-2); (iii) intercept and slope shifts, C/S (GH-3); and (iv) intercept, slope and trend shifts, C/S/T (GH-4). The inferred Gregory and Hansen equations for the IRPT equations are specified respectively as:

$$y_{it} = \alpha_{i1} + \alpha_{i2}D_{it} + \beta_i x_t + \varepsilon_{it} \quad (2)$$

$$y_{it} = \alpha_{i1} + \alpha_{i2}D_{it} + \varphi_i t_i + \beta_i x_t + \varepsilon_{it} \quad (3)$$

$$y_{it} = \alpha_{i1} + \alpha_{i2}D_{it} + \beta_{i1}x_t + \beta_{i2}x_t D_{it} + \varepsilon_{it} \quad (4)$$

$$yi_t = \alpha_{i1} + \alpha_{i2}D_{it} + \varphi_i t_i + \beta_{i1}x_t + \beta_{i2}x_t D_{it} + \varepsilon_{it} \quad (5)$$

where y_{it}, α_{i1}, x_t, β_i and $\boldsymbol{\varepsilon_{it}}$ are as earlier defined. *t* is a time trend, parameters α_{i1} and $\alpha_{i2}$are the respective intercept terms before and after the break, φ is the coefficient for time trend, $\beta_1$and β_2 are the respective pass-through coefficients of the retail interest rates before and after the structural break. The variables y_t and x_t are expected to be *I(1)* while ε_{it} should be *I(0)*. D_t is a dummy variable of the form:

$$D_t = \begin{cases} 0, if\ t \leq [T\tau] \\ 1, if\ t > [T\tau] \end{cases}$$

where the unknown relative timing of the break date is denoted as $\tau \in J$, [:] denotes the integer part operator and J is the trimming region belonging to a compact set of (0,1).[8] Gregory and Hansen (1996) proposed the test for cointegration with an unknown break date, which involves computing the usual statistics (ADF and Philips-Perron test statistics) for each possible break point $\tau \in J$ and then selecting the smallest value (the largest negative value) obtained across all possible break points, since this will potentially present greater evidence against the null hypothesis of no cointegration. In this regard, the relevant statistics are the GH-ADF (τ), GH-$Z_\alpha(\tau)$ and GH-$Z_t(\tau)$. Of

[8] Gregory and Hansen (1996) consistent with the earlier literature proposed J = (0.15, 0.85). This implies that the grid search for the appropriate break date should take place within the interval of 70% of the series of interest.

equations (2) to (5), the model that provides the best fit to the data is selected based on AIC.

After testing for cointegration, we estimate symmetric error correction model for each of the retail interest rates as follows:

$$\Delta y_t = \alpha_i + \sum_{i=0}^{s} \beta_i \, \Delta X_{t-i} + \sum_{j=1}^{q} \gamma_j \, \Delta Y_{t-j} + \rho \varepsilon_{t-1} \; + \mu_t \qquad (6)$$

where ρ measures the speed of adjustment, ε_{t-1} is the one period lag of the residuals from the appropriate Gregory-Hansen long run specification selected based on AIC, which has taken care of the bias from possible misspecification error due to structural breaks.

Lastly, the possibility of asymmetric adjustment process is investigated based on the approach adopted by Scholnick (1996). This involves partitioning the residuals from the appropriate Gregory-Hansen long run specification into two parts, namely $\varepsilon^{positive}$ and $\varepsilon^{negative}$ depending on whether ε_{it} is below or above its long run average at each period.[9] Thus, the residuals ε_t are divided as follows:

$$\varepsilon^{positive} = \varepsilon_t, \quad if \; \varepsilon_t > \mu$$

$$\varepsilon^{positive} = 0, \quad if \; \varepsilon_t < \mu$$

and

$$\varepsilon^{negative} = \varepsilon_t, \quad if \; \varepsilon_t < \mu$$

$$\varepsilon^{negative} = 0, \quad if \; \varepsilon_t > \mu$$

where μ is the mean of ε_t. We then proceed to estimate an asymmetric short run dynamic equation of the form:

$$\Delta y_t = \alpha_i + \sum_{i=0}^{s} \beta_i \, \Delta X_{t-i} + \sum_{j=1}^{q} \gamma_j \, \Delta Y_{t-j} + \rho_1 \varepsilon_{t-1}^{positive} + \rho_2 \varepsilon_{t-1}^{negative} + \mu_t \qquad (7)$$

[9] Scholnick (1996) has observed that such partitioning will not affect the estimation of ε or the cointegrating vector. A related procedure advanced by Chan (1993) is to sort the series ε in ascending order ranging from the smallest to the largest value regardless of time.

where $\rho_1 \; and \; \rho_2$ are adjustment coefficients when the residuals is above and below its mean, respectively. A test for asymmetric adjustment is conducted by testing the restriction that the two error correction coefficients in equation (7) are equal (that is testing the null hypothesis, Ho: $\rho_1 = \rho_2$). If the Wald test shows that they are equal, then, there is no evidence of asymmetry. The procedure for calculating the span of time required for the retail rates to converge to their long run equilibrium, regarded as the mean adjustment lags (MAL) was proposed by Doornik and Hendry (1994) as follows:

$$MAL^{positive} = (1 - \beta_i)/\rho_1 \qquad (8)$$

$$MAL^{negative} = (1 - \beta_i)/\rho_2 \qquad (9)$$

where $\beta_i$is the estimated short run interest rate pass-through coefficient and $\rho_1 \; and \; \rho_2$ are the corresponding error correction coefficients in equation (7). A high MAL implies slow adjustment of the retail rates to mpr changes while a low MAL indicates a quick adjustment.[10]

4.0 Results

In this section, we present our findings regarding the existence of a long relationship between the policy rate (mpr) and each of the retail rates (mlr, plr, sr, tdr1, tdr3, tdr6, tdr12). The long run interest rate pass-through coefficients are estimated for the retail rates that are cointegrated with the policy rate and the results of their short run dynamics are presented. The results of the tests regarding the nature and speed of the adjustments of the retail rates to changes in the policy rates are also presented.

4.1 Stationarity Test Results

The order of integration of the variables is investigated using the Augmented Dickey Fuller (ADF) and Phillips-Perron tests. At the one per cent significance level, the tests results showed that the mpr, mlr, plr, sr, tdr1, tdr3, tdr6 and tdr12 are integrated of order 1 and could be differenced once to attain stationarity (Table 2). This implies that the Engle Granger cointegration and error correction approach can be applied to

[10] Another plausible way of testing for no asymmetry is to use the Wald test with a $\chi^2(1)$ distribution to test the restriction that (8) is equal to (9).

investigate the long and short run relationships between the mpr and each of the retail rates.

Table 2: Unit Root Test Results

Variable	Levels		First Difference		Decision
	ADF^c	PP^c	ADF^c	PP^c	
mpr	-2.4278	-2.4218	-12.1025	-12.1212	I(1)
mlr	-2.5159	-2.4639	-13.3880	-13.3626	I(1)
plr	-3.2167	-3.1127	-10.2495	-10.1123	I(1)
sr	-1.9736	-3.7217	-11.0915	-30.6821	I(1)
tdr1	-2.1659	-2.2714	-6.5503	-14.4842	I(1)
tdr3	-2.4800	-2.4412	-14.8249	-14.6712	I(1)
tdr6	-2.8478	-2.6398	-12.4350	-14.8679	I(1)
tdr12	-3.0288	-2.8493	-12.6752	-19.1925	I(1)

ADF^c and PP^c represent unit root test with constant

****MacKinnon (1996) critical values with constant are -3.4731 (1%), -2.8802 (5%) and -2.5768 (10%)***

4.2 Cointegration Test Results

In order to investigate the existence of long run relationships between the monetary policy rate (mpr) and each of the retail rates, we test for cointegration using both the Engle and Granger and the Gregory-Hansen residual-based cointegration tests. The results of the Engle and Granger residual based test presented in Table 3 showed that at the 5 per cent significance level, the mpr is cointegrated with sr and tdr6.

Table 3: Engle and Granger Cointegration Test Results

Model	t-Statistic	P-value
mlr	-1.7594	0.3995
plr	-2.2585	0.1869
sr	-5.3686	0.0000
tdr1	-1.8884	0.3371
tdr3	-2.3881	0.1468
tdr6	-2.9413	0.0430
tdr12	-2.3600	0.1549

However, the test failed to find any long run relationship between the mpr and each of the remaining five retail interest rate variables. Since the Engle and Granger (1987) approach to testing for cointegration has been known to possess low power in the presence of structural breaks (Harris and Sollis, 2003), we proceed to employ the Gregory and Hansen (1996) approach and the results are presented in Table 4.

Table 4: Gregory-Hansen Cointegration Test Results

Model	Statistic	GH-1 Regression (Intercept Shift)	GH-2 Regression (Intercept Shift with Trend)	GH-3 Regression (Intercept & Slope Shifts)
MLR	GH Test Statistic (ADF)	-4.6852	-4.6990	-4.3216
	Break Date	2008M02	2008M02	2007M11
	AIC	4.9825	4.9287	4.9365
PLR	GH Test Statistic (ADF)	-3.4651	-5.1922**	-5.5163**
	Break Date	2003M12	2008M01	2007M08
	AIC	4.1182	4.0224	4.1472
SR	GH Test Statistic (Z_a)	-76.7629**	-86.9217**	-78.6141**
	Break Date	2010M06	2012M12	2010M07
	AIC	2.1670	2.6880	2.7155
TDR1	GH Test Statistic (ADF)	-3.8601	-3.7511	-3.8377
	Break Date	2009M05	2011M02	2009M05
	AIC	4.7394	4.4398	4.7718
TDR3	GH Test Statistic (ADF)	-3.6392	-3.9568	-3.9296
	Break Date	2010M06	2010M06	2010M06
	AIC	4.6672	4.3984	4.6991
TDR6	GH Test Statistic (ADF)	-3.9070	-4.5685	-4.3948
	Break Date	2010M08	2010M06	2010M06
	AIC	4.8823	4.6788	4.9136
TDR12	GH Test Statistic (ADF)	-3.3196	-3.5673	-3.4391
	Break Date	2010M05	2010M05	2010M05
	AIC	5.0107	4.8276	5.0387

The 5% critical values are -4.61, -4.99, -4.95 and -40.48, -47.96, 47.04 for the ADF*and Za* tests, respectively (Table 1a of Gregory and Hansen, 1996)

The Gregory-Hansen cointegration test results corroborated the Engle-Granger cointegration test, confirming the existence of a long run relationship between the mpr and sr, but with a significant structural break in June 2010, December 2012 and July 2010 for Model C, Model C/T and Model C/S. respectively. However, while the Engle-Granger results failed to find cointegration between the mpr and plr, the Gregory-Hansen approach confirmed the existence of a cointegrating relationship which changed in January 2008 and August 2007 for Model C/T and Model C/S, respectively. There was, however, no evidence of cointegration between the policy rate and the other retail rates. The effects of the identified structural breaks were therefore accommodated in the error correction models estimated for plr and sr.

Overall, the Engle-Granger and Gregory-Hansen cointegration tests confirmed that the mpr is cointegrated with the pls, sr and tdr6. Consequently, we proceed to estimate the long run interest rate pass-through coefficients for the three retail rates.

4.3 Long-run Pass-through Coefficients

The estimated long-run pass-through coefficients for the three retail rates (plr, sr and td6) are significant and positive (Table 5). In the case of the prime lending rate (plr), the long–run coefficient of 0.25 implies an incomplete pass-through. In other words, banks' lending rates react less proportionally to the policy rate, suggestive of the possibility of the banks perceiving their prime borrowers as being less risky. The results of the Wald test also suggested that the long-run pass-through coefficient is significantly different from unity (1).

Table 5: Long-run Estimates of Pass-Through Coefficients

Rates	Long-run pass-through coefficient	Wald test: long-run coefficient=1
plr	0.2520***	-12.4257***
sr	0.1639***	-42.2735***
tdr6	0.5593***	-7.168***

****** indicates significance at 1 per cent level***

As with plr, the long-run pass-through coefficient for the savings rate (sr) is significantly less than unity, indicating an incomplete pass-through from mpr to sr. At 0.5593, the highest level of long-run pass-through was recorded for tdr6 even though it was also significantly different from unity, as revealed by the Wald test. These results imply an incomplete and slow pass-through, which seem to suggest that the interest rate channel of monetary policy in Nigeria is quite weak. These findings are broadly in line with the results obtained by all the earlier studies on IRPT in Nigeria.

4.4 Short-run Coefficients and Asymmetric Adjustments

Table 6 presents the results of the short run analysis of the relationship between the policy rate and the retail interest rates (plr, sr and tdr6). Of the three rates, only the savings rate (sr) recorded a significant short run pass-through coefficient. The error correction coefficients for the three models were highly significant and negative, providing further evidence of the existence of long run relationship between the mpr and the three variables. The sizes of the error correction coefficients seem to suggest a

sluggish speed of convergence of the retail rates to their long run equilibrium. At 0.1693, the fastest speed of adjustment was recorded by sr, implying that about 16.9 per cent of the disequilibrium error is corrected within a month. Similarly, tdr6 and plr recorded adjustment speeds of 11.73 and 7.05 per cent per month, respectively.

The results of the asymmetric version of the estimated single equation error correction model (ECM) showed the pattern of responses of the retail rates to positive and negative shocks to the monetary policy rate implemented by the Central Bank of Nigeria. The results presented in Table 6 indicated that plr and tdr6 do not adjust differently to equilibrium based on whether they are high or low relative to their equilibrium relationship with respect to the monetary policy rate. In other words, the two rates respond in the same way to both positive and negative innovations in the mpr. However, the null hypothesis that the coefficients ρ^+ *and* ρ^- are equal was rejected for sr, implying that there is short run asymmetry in the way banks adjust their savings rate to changes in the monetary policy rate.

Furthermore, the estimated asymmetric coefficients showed that the savings rate (sr) adjust faster when they are high relative to their long-run equilibrium than when they are low. In other words, the speed of adjustment of the savings rate to increases in the mpr is faster when compared to the adjustment to decreases in the policy rate.

Table 6: Short-run Estimates

	Symmetric		Asymmetric			
					Wald test: $\rho^+ = \rho^-$	
Variable	β	ρ	ρ^+	ρ^-	$\chi 2$	*P-value*
plr	0.0158	-0.0705***	-0.0949**	-0.0281	0.7097	0.3995
sr	-0.1131**	-0.1693***	-0.4726***	0.1113	17.6840	0.0000
tdr6	-0.2142	-0.1173***	-0.1186**	-0.1155	0.0007	0.9783

*** and *** indicate significance at 5 per cent and 1 per cent levels, respectively*

The results of the mean adjustment lag (MAL) statistics computed based on the estimated error correction models for the three retail rates are presented in Table 7. The MAL presents the duration within which the retail rates experience complete pass-through. Based on the fact that monthly series are used for our study, the MAL shows

the number of months required for the changes in the mpr to be fully transmitted to the retail rates.

Table 7: Adjustment Mean Lag

Variable	Symmetric	Asymmetric	
		Positive	Negative
plr	-13.9603	-	-
sr	-6.5747	-1.8766	7.9686
tdr6	-10.3512	-	-

As noted earlier, the savings rate (sr) recorded the lowest asymmetric MAL implying that the fastest speed of adjustment occurs in the sr, compared to the other rates. The computed MAL for the response of sr to positive mpr shocks is about -1.88, implying that positive innovations in the mpr are fully reflected in the savings rate within two months. However, a negative shock to the mpr initiated by the CBN is fully reflected in the savings rate in about 8 months.

The computed symmetric MAL for the plr and tdr6 are -13.96 and -10.35, respectively. These imply that innovations to the mpr implemented by the CBN are fully transmitted to the prime lending rate in about 14 months while the full pass-through to the 6-month time deposit rate takes place in about 11 months.

5.0 Conclusion

In this paper, we extended the Neumark and Sharpe (1992) approach to the study of interest rate pass-through by accommodating structural breaks in the cointegrating relationships between the monetary policy rate and each of the retail interest rates considered. The empirical analysis was conducted using monthly data spanning 2002:01 to 2014:12. The cointegration tests based on Engle and Granger (1987) and Gregory and Hansen (1996) indicated that only three out of the seven retail rates considered were cointegrated with the policy rate. The Gregory and Hansen (1996) cointegration test with structural break confirmed that the regressions for plr and sr recorded structural breaks during January 2008/August 2007 and June/July 2010/December 2012, respectively, depending on which of the Gregory-Hansen model is applicable. These periods coincided with the period of the last global financial crisis.

The effects of the identified structural breaks were accordingly incorporated into the estimated error correction models for the qualifying retail interest rates (plr, sr and tdr6).

For the three variables with which the mpr was cointegrated, we estimated the long run and short run interest rate pass-through and investigated their adjustment patterns to innovations in the policy rate implemented by the Central Bank of Nigeria. Apart from accounting for structural breaks in our modelling approach, we also allowed for possible asymmetries in the adjustment of each of the retail rates to its long run equilibrium. The results are quite revealing.

First, we found evidence of incomplete pass-through in the long run coefficients of the cointegrating regressions for plr, sr and tdr6, implying a low and sluggish pass-through of changes in the mpr to the three rates. These findings are not different from the findings of earlier studies r carried out on Nigeria. Second, we found that the adjustment pattern of the plr and tdr6 to changes in the mpr were symmetric while that of sr was asymmetric. The implication of this is that the way banks adjust their savings rate depend on whether the change in the policy rate is that of an increase or a decrease. Third, the computed mean adjustment lag for the savings rate showed that its adjustment to positive innovations in the mpr is faster than that of a decrease in the mpr. We found that the effects of an increase in the mpr are fully reflected in the savings rate within 2 months. However, it takes about 8 months for the effects of a decline in the mpr to be fully transmitted to the savings rate. Fourth, we found that the adjustments of the plr and tdr6 to changes in the mpr were fully transmitted to the prime lending rate in about 14 months while that of the 6-month time deposit rate was about 11 months.

Overall, we found that the pass-through of the policy rate to the retail interest rates is incomplete and weak while the adjustment process is quite rigid, especially for the prime lending rate and the 6-month time deposit rate. It is recommended that the monetary authority factors in the size of the pass-through as well as the heterogeneities found in the adjustment process of the retail rates when taking decisions on its policy rate. The low IRPT obtained suggests that for desired policy outcomes to be realized, a stronger monetary policy stance may be required.

Indeed, the low and incomplete pass-through found in this study is hardly surprising given that the interest rate channel of monetary policy transmission is weak in Nigeria. The results may have resulted from a mixture of several factors such as the less developed and not too well-functioning financial markets, financial markets imperfection (less competitive markets), oligopolistic nature of the financial system, high switching costs, fixed menu costs, and information asymmetric. More importantly, the strong presence of public sector dominance (government and its agencies) in the financial markets—both loans and deposits markets, may also have influenced the kind of results obtained. The low and incomplete pass-through recorded for some of the retail rates is suggestive of the fact that interest rates in Nigeria are not wholly influenced by the market but by other external factors. The absence of any cointegrating relationship between the mpr and most of the retail interest rates raises the question of the efficacy of monetary policy actions in Nigeria. In conclusion, there is need for a comprehensive review of the current monetary policy strategy in Nigeria complemented with the pursuit of further banking/financial sector reforms.

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